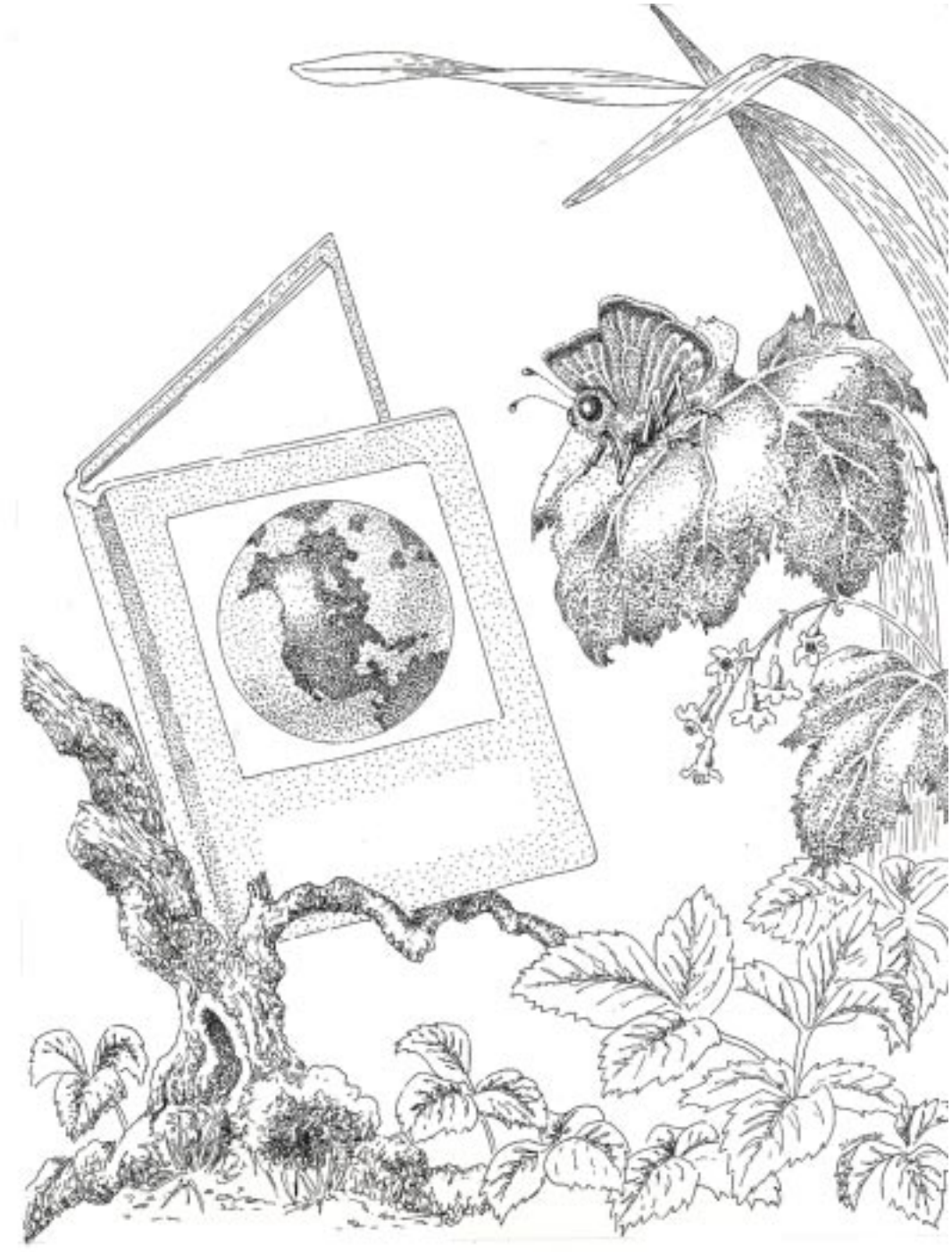
Section 7
Learn More About ...



LEARN MORE ABOUT...

7.1 PROPAGATION HINTS FOR COMMON OCEANA PLANTS

California brome grass/*Bromus carinatus*/BRCA
Sow: May/early June
Pot Size: Leach tubes/lukes
Survival Rate: 75 to 80 percent (to have 750 plants at the end of the growing season, sow 750/0.75 pots with seed, or about 1,000 pots; ten or eleven racks of Leach tubes or forty racks of lukes)

Coast buckwheat/*Eriogonum latifolium*/ERLA
Sow: May/early June
Pot Size: Vaders if sown May/early June; lukes if sown later
Survival Rate: 80 to 85 percent (to have 750 plants at the end of growing season, sow 750/0.80 or 937.5 plants. Round up to 1,000 plants; forty racks of lukes or fifty racks of vaders)

Phacelia/*Phacelia californica*/PHCA
Sow: June
Pot Size: 4-inch pots or vaders
Survival Rate: 70 percent (to have 600 at the end of the growing season, sow 600/0.70, or about 900 pots; forty-five racks of vaders or about fifty-six flats with 4-inch pots)

Red fescue grass/*Festuca rubra*/FERU
Sow: May/early June
Pot Size: SC10 (Leach tubes) or D-16 (lukes)
Survival Rate: 75 to 80 percent (to have 750 plants at the end of the growing season, sow 750/0.75 pots with seed, or about 1,000 pots; ten or eleven racks of Leach tubes or forty racks of lukes)

Yarrow/*Achillea millifolia*/ACMI
Sow: May/early June
Pot Size: Vaders if sown May/early June; lukes if sown later
Survival Rate: 70 to 80 percent (to have 200 plants at the end of the growing season, sow 200/0.70 pots with seed, or about 285-300 pots, twelve racks of lukes)

7.2 SEMI-HARDWOOD OR SOFTWOOD CUTTINGS FOR PLANTS: STEPS FOR SUCCESS

These cuttings are usually taken late spring to late summer and are not usually done at Oceana.

- Clean surface on which cuttings will be prepared.

- Wash hands.

- Decide how much material needs to be obtained from the field and how many cuttings are to be taken.

- Obtain material from the field, disease- and insect-free.

- For most softwood or semi-hardwood cuttings, a 3- or 4-node cutting works well.

- Go through all the material making the proper size and number of cuttings; don't remove leaves and trim yet.

- After making all the cuttings the right size, remove leaves from the bottom half of cutting if nodes are very close together, or from the bottom two nodes. Be careful not to strip the epidermis by pulling the leaves off the cutting.

- If a shrub species, pinch out the tip of the cutting (it will usually wilt anyway because it is so soft). Pinching will also encourage branching in the plant.

- Cut the bottom of the cutting at a 45-degree angle.

- Keep prepared cuttings in a plastic bag so they don't wilt. Keep them out of the sun.

- When all cuttings are prepared, put them in a colander and dip the colander in a bleach solution (very dilute, 1/2 teaspoon per 1 gallon of water); let soak for 30 seconds, no more than 1 minute.

- Pull out and rinse well.

- Obtain flat filled with cutting mix that has been watered in and allowed to drain.

- Use a clean piece of lath just shorter than the width of the flat to make ten lines (indentations) in the flat, using the thin edge.

- Put small amount of hormone in a small shallow container (1/2 pint deli container works well and lid can be put on to store excess). Never dip stems in original hormone container, as you will contaminate it. When finished, do not put excess back into original container-cover and label container with strength (#1, etc.) and put in refrigerator.

- Touch the bottom of cutting in the hormone (if a powder) or dip 5 seconds (if a liquid).

- Stick cutting in the first row in the flat; 20 cuttings per row, 200 per flat.

- When flat is full, tap on table to settle mix around each cutting.

- Label each flat, include number of cuttings and number of hormone (e.g., 200cc #3).

- Record in Propagation and Transplant Record Book.

- Take flat to location as instructed and gently water in, until water comes out from bottom of flat.

- Be sure the mist system is working.
- Clean up your mess.

7.3 HARDWOOD CUTTINGS: STEPS FOR SUCCESS

This process is not usually done at Oceana.

Preparation

- Clean pots or deep flats with dilute bleach water, remove dirt, let soak 30 seconds, remove from solution, and rinse with clear water.
- Make media of perlite and vermiculite:
  - Normally 5 scoops perlite to 1 scoop vermiculite.
  - For riparian plants (willows, cottonwood, dogwood, snowberry), mix 3 to 1.
  - For coastal scrub plants (*Ceanothus*, coffeeberry, manzanita), mix 7 to 1.
- Fill pots or flats to the top with the mix and level off with a straight-edge.
- Water in with a gentle spray, using a fanhead nozzle.
- While containers are draining, collect cuttings.

Collection

- Identify species of plant.
- Find a branch that is at least as big around as a pencil.
- Cut at the beginning of this year's growth, which can be identified by its lighter color and absence of rings around stem.
- Keep cut branches in the shade, in plastic.
- Cut the number of branches needed.
- Take to the nursery.

Making the Cuttings

- Remove any leaves on stems.
- Starting at the bottom of the branch, cut below the bottom node (where a leaf was) at a 45-degree angle (diagonally).
- Make the next cut above the next node up the stem at just a slight angle.
- Put cutting in a clean flat (or bucket of water if weather is hot), keep the growing end pointing up.
- Continue until the stem is no longer as big around as a pencil; discard the skinny portion.
- Keep track of the top and bottom of the cuttings (look for little buds at the nodes; they point up).
- If very difficult to root, wound the bottom by shaving off the bark on one side of the cutting.
- When all the branches are cut, you are ready to stick the cuttings.

Sticking the Cuttings

- Wear rubber gloves.
- Put cuttings in bleach water, 1 teaspoon per gallon, for 30 seconds, and rinse; keep them pointing the right way.
- Get a flat or pot and put on one side of you, cuttings on the other side.
- Get hormone (for willows, cottonwood, snowberry, use #1).
- Count out ten cuttings.
- Touch the bottom of the cuttings to the hormone powder.
- Stick cuttings in rows, ten rows per flat, twenty cuttings per row.

Finishing

- Make a label with:
  - four-letter species abbreviation;
  - date taken;
  - number of cuttings in flat;
  - number of hormone used.
- Water in gently with fanhead nozzle

to settle mix around cutting.

- Put on bench as directed. (Usually outside on a shaded bench. If cuttings are inside, in a greenhouse, the upper buds will break because the plant feels like it's spring; then the plant will use all the food stored in the stem before the roots can form.)
- Record total cuttings on Propagation Sheet.
- Clean up your mess.

7.4 PLANT NUTRITION

In order for a plant to grow and remain healthy, sixteen elements need to be supplied to the plant. If these elements are not present in necessary amounts, the plant will be stunted or display other problems. Macronutrients are needed in larger amounts; micronutrients are needed in smaller amounts.

The essential nutrients can be remembered using the saying, "C HOPKNS CaFe, managed by mine cousins, Mo and Clyde." (see if you can figure that one out!).

Carbon, hydrogen and oxygen are absorbed from the air through the **stomata** in the leaf or from water, and are needed for virtually every chemical reaction within the plant. They comprise the end product of **photosynthesis**: carbohydrates.

$CO_2 + H_2O \rightarrow C_6H_{12}O_6$ (sugars)

C H O + N S P → proteins also produced by plants

These two products feed the people of the world and, of course, other living things for which we are restoring habitat. The plants use them for growth and for storing energy for the following year.

Macronutrients	
Carbon	C
Hydrogen	H
Oxygen	O
Phosphorus	P
Potassium	K
Nitrogen	N
Sulfur	S
Calcium	Ca
Iron	Fe
Magnesium	Mg
Micronutrients	
Boron	B
Manganese	Mn
Copper	Cu
Zinc	Zn
Molybdenum	Mo
Chlorine	Cl

There is usually plenty of carbon dioxide (CO_2) and water (H_2O) around, so these are not limiting factors. Greenhouses growing high-value crops such as roses will sometimes pump in carbon dioxide to speed growth. Proteins make up **protoplasm** and are the main component of stored food in the plant. In one plant, carbon made up 45 percent of its dry weight;

hydrogen, 6 percent; and oxygen, 43 percent, accounting for all but 6 percent of the total weight of the plant.

Nitrogen (N) is an integral part of the protein molecule and is the element usually most lacking in a growing system. It is also a component of chlorophyll, nucleic acids (DNA, RNA), amino acids (building blocks of proteins), and hormones. Plants can absorb nitrogen through the roots only as nitrate (NO_3^-) or ammonium (NH_4^+). Larger organic molecules, like urea, must be broken down by soil microorganisms to these smaller molecules in order to be used by the plant. Nitrogen, as nitrate or ammonium, **translocates** easily in the plant. It also dissolves easily in water, and so **leaches** from the pot rapidly. It typically makes up 1 to 4 percent of the dry weight of a plant.

Too little nitrogen will cause a yellowing (**chlorosis**) of the leaves, especially older ones (since it translocates, it moves from old to young leaves in order to keep the plant growing), and a general stunting of the plant. The plant will be deficient in proteins and stored food. Too much nitrogen can be just as bad, especially in our nurseries, because it causes the top of the plant to outgrow the roots, creating a low root-to-shoot ratio. If nitrogen is supplied in high amounts or late in the season, the tops will keep growing rather than converting energy to stored food. Excess nitrogen will also delay flowering, fruit and seed development, and encourage lots of vegetative growth.

Phosphorus (P) is also a major component in proteins, sugars, RNA, and ATP (chemical energy source in the plant). Even though less than 1 percent of the dry weight of a plant is phosphorous, it is essential for cell metabolism. Sufficient phosphorus encourages good root development and speeds fruiting and seed development. It is needed early in the growing cycle for root development, which begins before shoot growth. Our mix has a superphosphate (natural crushed rock) in it, which has 20 percent phosphorous, also 18 percent calcium, and 12 percent sulfur.

Potassium (K) is needed during rapid growth. It translocates from older tissues to the growing points (meristematic regions) of the plant. It is an **enzyme** activator for cell division, synthesis and translocation of carbohydrates, synthesis of proteins, development of chlorophyll, and stomatal opening and closing. It also helps prevent infections such as root rot.

Potassium deficiencies will show up as dead spots (necrotic lesions) on the leaves as well as yellowing. California soils usually have enough potassium with high pH (basic soils), but it can be deficient in low pH (acidic) soils such as those in redwood or other conifer forests. Lime (calcium carbonate) is used to neutralize acid; chemically, it is close to baking soda or Tums.

Sulfur (S), found in many amino acids and vitamins, is needed for enzyme actions and in photosynthesis reactions. It is less mobile in the plant than nitrogen, potassium, or phosphorous. When deficient, the plant fails to synthesize proteins from the amino acids present. Sulfur is absorbed by the roots as SO_3 from the soil solution.

Calcium (Ca) builds strong bodies (structure) in plants. It is the essential constituent of cell walls. Needed early in the season and during rapid growth phases, it concentrates at the growing points. It is immobile and if not available in the **apical meristem**, the top of the plant will twist and deform and the tips will die; root growth will also be restricted. Eventually, the plant will die. It is required for cell division, **chromosome** stability, and **mitochondrial** production (energy stored

within the cells). Calcium is usually sufficient in California soils unless rainfall is very high or the soil is acid.

Magnesium (Mg) is the center of the chlorophyll molecule. Need we say more? Chlorophyll, which is essential for photosynthesis, converts CH and O to food. It is where all our food comes from, vegetables and/or meat from animals. Magnesium is involved in many enzyme reactions. Deficiencies show as yellowing of the older leaves and general sickliness of the plant.

Iron (Fe) plays a role in the conversion of energy from the sun into chemical energy in the plant (ATP). It is essential for chlorophyll formation but is not part of the end-product molecule. It is usually present in sufficient amounts in the soil but may be held tightly to the soil particles if the pH is too high or if the soil is poorly aerated. Iron deficiency shows as **intervenal chlorosis**. An adjustment in the pH or improving the drainage will usually make sufficient iron available to the plant.

Micronutrients are needed by plants in minute amounts and are usually sufficiently available. However, they may be deficient in a non-soil medium. Nutricote, a slow release fertilizer, and Plantex, a soluble fertilizer, have had micronutrients added to them.

So now we know what the plants need. How do we figure out what we need to give them, how to give it to them, and how much to give them? It's not easy or straightforward, especially for native plants. Optimum levels of the various nutrients have been established for species perceived to have economic value—most grains, vegetables, fruits, some high value ornamentals, and some timber species—but there has been no funding for research to establish optimum requirements for all the native plants.

However, even if we knew the optimum levels needed for every species we grow, it would not be practical to fertilize each species differently. Consequently, we have established a standard formula that works well on most species, varying it on the few species with very special requirements. This standard formula was discovered through experience and observation. Since plants will grow well within a relatively broad range of concentrations, we tend to give fairly high amounts of some nutrients in order to avoid a deficit of others. As we refine our knowledge of what our particular plants require, we can customize our procedures. We also continue to work on incorporating compost into our mixes and using organic, non-petrochemical-derived fertilizers.

Most landscape nurseries give a constant feed of N at 200 parts per million (ppm). We have found that 50 to 75 ppm N works well as a constant feed for most of our native plants. Nitrogen is usually the limiting factor to good growth; superphosphate in the potting mix gives adequate P for young growth. Superphosphate and the slow-release Nutricote are used up in about three months, which is why the pots are top-dressed with the slow-release fertilizer three months after transplanting. Herbaceous plants started later in the season need to be fertilized later. Fertilization stops after October 1, as our plants need to go dormant by November.

7.5 NATIVE PLANT NURSERY PESTS: IDENTIFICATION AND CONTROL

Horticultural and biological controls are our first lines of defense against nursery pests (usually snails, slugs, insects, and/or diseases). If these are not successful and the problem worsens, call the nursery specialist or the park's integrated pest management (IPM) specialist. No chemicals (including oils or soaps) or plant-derived treatments (like rotenone) can be applied without the IPM specialist's supervision.

Snails and Slugs

Like clams, snails are members of the mollusk family. Slugs, which are like snails without shells, are also mollusks. Our common brown garden snail is an escaped exotic, brought from Europe in the 1850s as a delicacy for American diners. Get rid of snails with no more regret than you experience pulling broom or Cape ivy. We do have a native snail that is solitary (doesn't congregate in groups) and not found in nurseries. The Decollate snail is a predator of the common brown snail and many other insects; if you see one, leave it alone.

Life cycle

Snails, which produce slime to move, take two months to four years to mature. They have two pairs of retractable tentacles; the long ones function as eyes and the short ones are for smelling. The mouth is below with a horn-like rasping organ that the snail uses to scrape away at leaves.

Though snails are **hermaphroditic** (having both male and female sexual organs), they do not usually fertilize themselves. They lay eggs in masses of about 100 white, round eggs; the egg mass is usually about 1 inch in diameter. (Slugs lay fewer eggs.) The eggs hatch when there is plenty of moisture.

Snails require abundant moisture throughout their life cycle. They feed at night; during the heat of the day they hide in cool, moist, dark places (like the bottom of plant racks or benches). Many use the same hiding place each night. If conditions are too dry, they pull into their shells and seal the opening with a mucus that hardens; this allows them to survive for up to four years! They overwinter in leaf litter, lumber, or other out of the way places (again, nursery pallets and benches), and are not usually active below 50°F.

Signs of Infestation

Snails will rasp (scrape) irregular shaped holes in leaf edges and middles. Slime trails are a dead giveaway.

Snail and Slug Control

Clean up. Get rid of hiding places. If lumber is stored at the nursery, put cross boards on the bottom so the pile dries out. Pull and dispose of tall weeds (especially vinca, ivy, or ice plant, which provide perfect hiding places). Debris and other hiding places should be cleaned up. The best cultural control for many pests and diseases is a neat and tidy nursery.

Hand pick (if there are only a few). This works only at night; two hours after sunset is the best time. How dedicated are you?

Traps. Use an overturned clay flower pot, a raised board, a large buried coffee can with beer in the bottom (this must be monitored every day). It's okay to squash them; even if there are eggs inside, they are immature and will dry out. Remember that our pot racks are great traps. If you see damage in a rack of plants, most likely the snail is hiding under the rack. Pick it

up and look on the bottom-side of the rack, between the pots.

Barriers. On our benches, copper strips are the most effective barrier. Wrap a strip around each bench leg and keep the strips clean (oxidation, green on the stips, will not affect the effectiveness of this method).

Predators. Ducks; chickens (do we want to go there?); or Decollate snails, which have been introduced in southern California from North Africa and feed on the brown garden snail. If you find a Decollate snail, it can be left to feed on the brown snails, but be sure it doesn't go to the field. The Decollate snail also likes seedlings, so beware.

Chemical controls. Snail bait can create new generations of resistant snails as well as poison dogs, cats, and other predators. If you want to use bait, call the nursery specialist first.

Insects

Insects have six legs and are divided into orders, a higher classification than families (commonly used with plants). They have chewing mouthparts or rasping-sucking mouthparts depending on their stage of development. A caterpillar chews leaves, a butterfly sucks nectar. Insects go through metamorphoses, both partial and complete. Insects that chew, leaving holes in leaves or cut stems, include grasshoppers, sowbugs, earwigs, crickets, and most beetles. Sucking insects include aphids, scales, true bugs, leafhoppers. and thrips. They insert their mouthparts into the **phloem** and remove sap or photosynthetic sugars; this causes leaves to curl, discolor, and drop.

Most of the insect problems in our nursery are from the *Hemipterans* and *Coleopterans*, true bugs (including aphids and scales) and weevils. When we consider how best to control insects, we must think about the ecosystem in which the pest lives, our nursery. That ecosystem must provide food and shelter. There may also be predators. Control usually means altering the food and shelter being provided for the pest.

Black vine weevil (strawberry root weevil)

Symptoms

Attacks roots of container plants. Plants suddenly look unhealthy, wilted, and dry. Examination of the root system shows that part or all of the roots have been eaten by the grubs. Plants can be easily pulled from the soil/container. Adult feeding gives a scalloped edge to the leaves.

Life Cycle

Black vine weevils cannot fly. They tend to stay within 30 feet of where they hatched; avoid grassy areas, preferring pavement or cleared walkways; and crawl under greenhouse doors or through vents. The adult feeds on the edge of leaves (thus, the scalloped effect). Feeding takes place only at night. They hide in the soil during the day. Weevils are all female; reproduction is parthenogenic. Egg laying begins about ten weeks after emergence from the pupal stage. The black vine weevil lays up to a thousand eggs between mid-May and mid-September. Eggs are laid in the soil and hatch in three weeks; the brown-headed white grubs feed on roots for two to three months before forming pupae. This stage lasts seven weeks.

Physical Controls

Physical barriers work for ants and weevils. Attach inverted pie pans to the legs of nursery benches; they must form tightly to the bench. Coat the underside with Tanglefoot or other sticky adhesive.

Seal the bottom of greenhouses with screen, weather-stripping, or caulking. Use screen vents.

Common Orders

Order	Example	Mouthparts	Metamorphosis	Antennae	Wings/Pairs
Odonata	dragonflies	chewing	complete	short	2 or none
Dictyoptera	cockroaches	chewing	gradual	segmented	2
Isoptera	termites	chewing	gradual	segmented	2
Dermaptera	earwigs	chewing	gradual	long	2
Orthoptera	grasshoppers	chewing	gradual	vary	2 or none
Phthiraptera	lice	chewing	gradual	short	none
Hemiptera, Homoptera	true bugs, aphids, scales, mealybugs	sucking	gradual or simple	vary	2 or none
Thysanoptera	thrips	rasping/sucking	intermediate	short-medium	2, fringed
Lepidoptera	butterflies & moths	sucking & chewing	complete	vary	2
Diptera	flies	sucking	complete	vary	1
Siphonaptera	fleas	piercing	complete	short	none
Neuroptera	lacewings	chewing	complete	look like sausage links	2
Coleoptera	beetles, weevils	chewing	complete	long	2
Hymenoptera	bees	chewing	complete	vary	2

Biological Controls

Nematodes, small, needle-nosed insects, often burrow into and feed on plant roots. However, two nematode species, *Stierernema carpocapsae* and *Heterorhabditis heliothidis*, are used as biological controls, burrowing into the weevil adult or grub in the soil. *H. Heliothidis*, which goes to greater soil depths, seems to be more effective.

Nematodes are mixed with water and applied as part of the irrigation process; they can be applied through a Syphonex or Dosatron injector (soil must also be moist before application). The nematodes, which live approximately three months, can begin laying eggs in May; one application is made then, followed by a second in August.

Once all weevils are killed, any nematodes remaining starve to death, so there should be no worry of contaminating a planting site with nematodes.

Aphids

There are over four thousand species of aphids, including green, black, blue, white, and woolly ones. They are all generally similar in appearance. An aphid injures plants by inserting its **stylet** and sucking plant juices. They often attack tender growing tips first.

Symptoms
Damage shows as curled, wilting, or deformed leaves; stunted growth; chlorosis; honeydew; and black sooty mold that grows on the honeydew.

Life Cycle
Aphids overwinter as shiny black eggs in bud scales or bark crevices. In spring, the mother hatches and proceeds to give live birth to only females; she does this through the spring and summer season (this is why aphid populations can increase so rapidly). In the fall, as days shorten, the females produce winged males that mate with females, producing the overwintering eggs. Depending on habitat condition, this cycle can vary from species to species.

Physical Controls
Screening: regular window screens will help exclude aphids from the greenhouse (manufacturers usually have "add-ons" for screening vents). Pinch or prune: pinch or prune off infested plant parts. Combine this with washing. Use a strong stream of water to remove much of the population. This will need to be repeated over several weeks. Soapy water may be used, but plants must be rinsed with clear water afterward to avoid having the soap kill the plant. Ant barriers: see description of barriers under weevil and snail sections.

Horticultural Controls
Reduce the nitrogen; aphids love soft, tender, new growth, which is increased by nitrogen. New growth has thin cuticle and cell walls, which make it easy for aphids to insert their mouth parts. Plants must be kept healthy. Plants stressed by overwatering or drying out can also fall prey to aphids.

Biological Controls
Maintain a native garden and encourage native predators, who will be there to eat the first aphids that hatch and keep populations in balance. Lots of insects eat aphids. Look for green lacewings, lady beetles, and gall midges. Midges are in the fly family; adults are small, fragile flies with very long legs, almost like small mosquitoes. They like members of the *Asteraceae* family and can often be found on dandelions and other composite flowers.

Collect midges from infested plants and bring into the greenhouse or shadehouse. To collect gall midges, place leaves and stem from a plant heavily infested with aphids in the field into a large clear-plastic bag. Blow up the bag like a balloon and close with twist ties. Put in a shady place for a day or two, then examine under a good light. Gall midges will be seen as tiny, orange, worm-shaped fly larvae clinging to the inside of the bag. Turn the bag over and more should come off the leaves and stick to the plastic. Use a fine paintbrush moistened with water to pick them up and transfer to your plants. The larvae take about five days to mature, and molt four times, killing aphids the whole time.

Scale
Two types, armored and soft, and in the same Order (*Homoptera*) as aphids. They can be controlled using the same methods, though scales' protective coating makes control more difficult than for aphids. Like the aphid, scale has a stylet that it uses to perforate the plant surface and suck out juices. They excrete honeydew, which does not harm the plant. However, it is soon host to black sooty mold fungus and ants.

Armored scale have scabs about 1/8 inch in diameter. They produce little honeydew. However, soft scale do produce honeydew and form a larger and darker shell. Ants eat the honeydew, so they actually farm the scale and cover them to protect them from harm.

Symptoms
Scale look like small bumps on leaves, twigs, and stems. Closer inspection reveals the shell cover. Scale and mealybugs normally do not move. Plant symptoms are the same as aphids: wilting, yellowing, possible distortion of leaves or stems, and a water-stressed look. When their shell is lifted, armored scale stay on the plant, but soft scale adhere to their shell.

Life Cycle
If the shell is turned over, eggs are revealed underneath. They hatch into crawlers with legs. For a few days they may walk around but gradually settle in one spot, molt, and form their shells. Scale will be found along the stem of a plant. Life cycles vary from species to species. Some have no males, some have male crawlers.

Monitoring is essential; a few scale will not harm a plant, but large populations can cause problems. If you are not sure if it is a plant bump or scale, use a penknife and scrape it; if it lifts up, it's a scale. Usually there will be honeydew on the leaf under the scale. Scale are protected by a shell at both the egg and adult stages, which makes control more difficult. The best time is at the newly hatched crawler stage, approximately a week after a mass of eggs is observed around the mother's body. When they hatch, they're most vulnerable to control methods.

Physical Controls
Rub them off by hand or with a cotton swab dipped in alcohol.

Horticultural Controls
Prune off infested parts and reduce nitrogen levels (scale love lush plants).

Biological Controls
Control ants. Parasitoids feed directly on scale; feeding is noted by tiny pin-size exit holes in shells. Mealybug destroyers, *Cryptolaemus montrouzieri*, also feed on scale and are commercially available. In their larval form, green lacewings feed on scale (adult lacewings feed on nectar and pollen only). The larvae look like little alligators and have a huge appetite.

Non-toxic Chemical Controls
Soaps are limited in effectiveness; horticultural oils like Sunspray or Volke, safe and more highly refined than oils in your kitchen, cover the scale and suffocate them and can be very effective. Permission of the IPM coordinator must be granted before using these oils.

Mealybugs
Close relatives of the soft scale; California has 193 species. In early infestations, they hide in leaf axils and snug places. Later, the colony's whitish, waxy covering make them very visible. Ants will pick them up and move them to a new site.

Symptoms
Same as aphids and scale.

Life Cycle
Each female produces up to a thousand eggs; there are as many as eight generations in a year, with instars after hatching (they molt three times and do not pupate); winged males live only a few days.

Physical Controls
Rub off by hand; control the ants with barriers, as ants will kill the natural predators. Rubbing alcohol and a swab on small infestations.

Horticultural Controls
Monitor plants frequently; control nitrogen levels. They will move to the roots or crown of a slow-growing plant; be sure to check this area when monitoring.

Biological Controls
Mealybug destroyers (as described for scales), which look like mealybugs in their larval stages; adults are small, red-and-orange ladybugs that tend to fly towards light when released, so they need to be enclosed. Green lacewings also eat mealybugs.

Non-toxic chemical controls. Mealybugs on roots can be treated by setting plant in soapy water until thoroughly wet; soil bacteria will break down the soap rapidly. Repeat in seven days. Check the root ball a week later; if mealybugs are still present, treat again. After control is achieved, leach the rest of the soap out of the soil with lots of water.

Horticultural oils, Sunspray or Stylet oils cover the pest or clog their stylets and can be very effective. IPM Specialist must grant permission before these oils can be used.

Arachnids

The Arachnid Class includes spider mites as well as spiders and ticks. Arachnids have eight legs.

Spider Mites

Symptoms
Stippling or tiny yellow or white spots on leaves. No brown or black spots. Leaves may turn pale green or yellow. Brown patches on the underside of leaves, webs formed if infestation is severe. Mites are tiny, about the size of this period. A hand lens is needed to see them clearly.

Life Cycle
An individual mite reaches adulthood in a few days, and they produce many generations per year. Live in colonies on the bottom of leaves. Immature mites resemble the adults. Adults hibernate in debris. Eggs are round and translucent, like tiny drops, turning cream color before hatching.

Physical Controls
They like hot, dry dusty conditions. Spray plants to raise humidity levels and keep clean. Keep plants out of direct afternoon sun. Shade to keep temperatures down.

Horticultural Controls
Keep plants in a non-stressed condition. Mites occur when plants are water-stressed, rootbound, or when plants are dusty and dry.

Biological Controls
Predator mites keep spider mites in balance but must be introduced early in order to keep up with rapid population growth.

Non-toxic Chemical Controls
We have not found insecticidal soaps to be effective for spider mite infestations, but might be used on a small population; 2 percent horticultural oil is very effective but needs to be reapplied periodically; sulfur can be phytotoxic in some cases—use carefully and check with nursery—or IPM Specialist before using any chemical.

It's pretty obvious that good horticultural practices are the best insect and mite controls. Plants should have sufficient but not high nitrogen levels so that they grow slowly and do not become rootbound. If this happens, make a note and start the plant later the following year, or put in a larger pot. Move plants from the greenhouse to the cooler shadehouse as soon as possible. Monitor for pests at least once a week.

References

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7.6 NATIVE PLANT NURSERY DISEASES AND CONTROLS

Three major diseases affect the native plant nursery. All are fungal and can do a tremendous amount of damage.

Scab (*Spilocaea* spp.)

It affects toyon (*Heteromeles arbutifolia*). Toyon is a member of the rose family (*Rosaceae*), and scab is a common disease for this group of plants. A closely related fungus, *Venturia* spp. occurs on coffeeberry (*Rhamnus californica*).

Symptoms

On seedlings, bronzing then scabby, crispy leaves, especially newest ones; new growth curls, crinkles, and dies. On mature leaves, and older plants, scabby spots, scattered over leaves; shoots may die.

Life Cycle and Progression

Scab fungi overwinter primarily on fallen leaves or on lesions on twigs. Germinates in cool, wet winter and spring weather. Will not grow if the environment is hot or dry.

Spores on the ground, on infected plant leaves, or on dead leaves on the ground or in the pot.

Rain or irrigation water splashes the spores from plant to plant.

To germinate, spores must be continuously wet for fourteen hours at 50°F (19°C). They grow a **hyphae** (vegetative strands) that pierce the cuticle of the leaf (or flower or fruit). Hyphae multiply and grow between the cuticle and outer wall of the epidermis. It takes several days for an infection to show; symptoms appear as the infected cells die.

Spores survive dry weather as dormant **conidiospores** that remain on the plant and germinate when climate is cool and wet again.

Control

Germinate and grow toyon only in a warm greenhouse, or outside after weather warms up and rains stop. Any toyon still in the nursery in the fall should be brought back into the greenhouse before winter rains begin.

No disease spreads as fast as scab on toyon. **Sanitation, sanitation!** Keep your feet out of the soil mix. Cull infected plants mercilessly. Move any funny-looking seedlings or plants away from healthy plants, or the next day, the healthy ones will be infected.

Clean up any fallen dead leaves.

An application of sulfur application (considered an organic treatment) can help prevent scab, but so will good horticultural practices.

Root Rot (*Phytophthora* spp.)

It affects most plants and its spores are everywhere. The hyphae grow through plants' xylem vessels (water-carrying cells) and clog them up. Then plants can't take up water, even though the ground is wet. Seedlings can be killed in a few days to months; small secondary feeder roots

are killed first, and brown areas will show on larger roots.

Particularly susceptible plants are:
Box elder (*Acer negundo californicum*)
Buckeye (*Aesculus californicum*)
Alder (*Alnus* spp.)
Madrone (*Arbutus menziesii*)
Manzanita (*Arctostaphylos* spp.)
Coyote bush (*Baccharis* spp.)
Ash (*Fraxinus latifolia*)
Flannel bush (*Fremontodendron californicum*)
Toyon (*Heteromeles arbutifolia*)
Northern California black walnut (*Juglans californica hindsii*)
Cottonwood, poplars (*Populus* spp.)
Bay, bay laurel, myrtle (*Umbellularia californica*)

Symptoms
Plants wilt even though soil is wet; additional watering worsens the plants' condition. Plants are stunted and slow-growing. Leaves are a darker-than-usual green. Branches on large plants or whole seedlings wilt and die. When you peel the bark, the epidermis and xylem area will be brownish rather than a healthy green. On cuttings, black areas appear first on the stem. Roots are first brown or black and firm and brittle, then soften and decay.

Life Cycle and Progression
Overwinters as **mycelium** in infected roots in the soil, or as dormant spores (oospores or chlamydospores).

In the spring, dormant spores germinate and swim (zoospores) around in the soil water until a susceptible root is found.

Overwatering causes epidermis cells to swell, burst, and leak sugars, attracting the zoospores, which need sugars to live; they enter the roots through cracks.

Zoospores thrive in cool wet weather. In hot, dry or too cold (under 59°F) weather, spores survive in one of the dormant forms.

Control
Sanitation. Clean soil, clean pots. Keep feet out of soil mix. Keep soil mix pile clean.

Use light, well-drained mix.

Be sure cutting material is free of infection.

Damping-off Diseases (*Pythium* spp., *Rhizoctonia* spp.) affects redwoods and many herbaceous plants.

Also found in soil and water, damping-off diseases are related to root rot and are often indistinguishable from it.

Symptoms
Very young seedlings flop over at soil level and die.

Roots become soft, mushy, darkened, and decayed.

More mature plants grow slowly, gradually decline, exhibit terminal dieback, and then die.

Life cycle
Similar to root rot.

Control
Same as for root rot: sanitation; soak seed flats in bleach solution; keep soil mix clean; don't overwater.

Powdery Mildew
It is caused by many species of fungus, and affects roses and new oak growth. Powdery white or grayish growth on leaves of susceptible plants. Some species infect many types of plants, and some species only infect a single species or plant. *Sphaerotheca pannosa* var. *rosae* infects roses. Unlike other fungi, they do not need

free water to germinate.

Symptoms
Gray or white blotches on leaves. “Witches broom,” whitish covering on new oak growth. Leaves and shoots become distorted, dwarfed, discolored, and crinkly; infected leaves drop prematurely.

Life Cycle
Spores are windblown.

White or gray spots on the plant contain hyphae and spores, often in chains that can be seen with a hand lens.

Survives in plant tissue and dormant buds (not in the soil).

Control
These measures only help if they are initiated before the disease is too far along. Monitor crops and take action as soon as symptoms are noticed.

Unlike other fungal diseases, spores germinate in dry conditions. Water and direct sunlight inhibit powdery mildew germination, so put plants in the sun.

Most spores of this species are formed in the mid-afternoon, and spraying the plants with water at this time will prevent germination and kill germinated spores. However, be sure to spray early enough in the afternoon so that plants can dry before nightfall to prevent other diseases.

Good air circulation helps, so space plants out if you can.

Prune infected tissue and remove from the area.

Powdery mildew likes tender new growth; don’t overfertilize and stop fertilizing entirely in early fall.

Keep every aspect of the nursery free of exotic weeds-pots, greenhouse, shadehouse, and areas near the nursery. Weeds can carry eggs and adult insects, pests, and fungal spores.

Monitoring
The take-home lesson for disease prevention and reduction is to monitor your nursery closely. Do daily inspections, make notes of what you see on the nursery monitoring form. Take the form with you while monitoring, and when possible, do your nursery checks with another responsible person, so you’re sure not to miss anything! Make quantitative notes.

7.7 BOTANICAL NOMENCLATURE

Every known living thing has been classified and given a name according to strict rules. This enables anyone anywhere in the world to understand and communicate about a particular plant or animal without confusion. As an employee or intern member of the nursery staff, you need to understand how this system works and become comfortable with it.

This is basic biology. Each rank is more specific as you go down the list (see Table on page 78).

The particular variety of California rose used in the table is called *Rosa californica* var. *brevifolia*. Usually, the genus and specific name are all that are used for our purposes. If there is a unique population of a plant, that has been given a variety or sub-species name we will use that too.

The ranks down through **variety** are all used for plants occurring naturally in the wild. If the plant has been bred by humans

or selected for a certain trait and reproduced **asexually** (clones), it is usually given a cultivar (cultivated variety) name. This is indicated by single quote marks around the cultivar name or cv. before the cultivar name, e.g. *Rosa californica* 'Pinkie'. The genus and species names are italicized because they are always in Latin, but the cultivar is named in the language of the breeder and is not italicized.

In botany, horticulture, and ecology, we usually start with the Family to identify a plant. The plant name we use is usually the genus and species name. That is, it's Latin binomial. The genus is always capitalized; the spcies is never capitalized unless it is derived from someone's name. The botanical name is always in *italics* or <u>underlined</u> since it is a foreign langugage.

Rank	Name ends in	Example
Kingdom division	.phyta	Tracheophyta
Class	.ae	Angiospermae
Subclass	.ae	Dicotyledonae
Order	.ales	Rosales
Family	..aceae	Rosaceae
Subfamily	.aideae	Rosaideae
Tribe	.eae	Roseae
Genus	..us, a, um, es, on, etc.	Rosa
Subgenus		
Specific Name (Species)	agrees in Latin with the Genus	californicia
Subspecies		
Variety		brevifolia
Cultivar (cultivated variety)	in Common Language (English)	'Pinkie' or cv. Pinkie